GRAZING HABITS OF DAIRY CATTLE AS AFFECTED BY WEATHER AND CHEMICAL COMPOSITION OF PASTURE

by

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INTRODUCTION

The dairy cow is the most efficient animal in converting, for human consumption, inedible roughage plant foodstuffs into milk, the best known food to man. Milk is one of the most important foodstuffs of the animal kingdom and is second only to water in importance in the life of man.

A large amount of food consumed by the dairy cow is roughage and much of this roughage is grass. Pasture is a natural feed for dairy cattle and in many respects the best, from both a physiological and a nutritional standpoint. Fresh pasture is palatable, succulent and contains vitamins, minerals and proteins in sufficient amounts to meet the requirements of a good dairy ration for economical milk production. Because of this, pasture is one of the most important crops that a dairyman can raise.

Except in a few specialized dairies and in a few sections of the United States, pasture grass is of the greatest importance in the efficient and economical production of milk. In many sections of the country the pasture available determines the number of cows which can be kept. There is an old Flemish proverb which says, "No grass, no cattle; no cattle, no manure; no manure, no crops." To some extent this is true to-day.

There are about 5,500,000 acres of land in the United States classified as permanent pasture. Permanent pasture is one of the most important crops in Kansas, Bluestem being the chief variety of permanent pasture grass in this section of Kansas.

Because pasture is so important to the Kansas dairymen and to dairymen throughout the United States this study was undertaken to determine, if possible, the effects that weather and the chemical composition of pasture would have on the grazing habits of dairy cattle. It was hoped that this information would shed some light on the proper management and utilization of permanent pasture.

Some work has been reported concerning the grazing habits of dairy and beef cattle. However, most of this information was obtained from a few cattle on small acreages, under controlled conditions, and not from cattle subjected to continuous grazing.

REVIEW OF LITERATURE

Not a great deal of recent work has been done concerning the grazing habits of dairy cattle. However, it is known that the weather and the composition of the pasture do have some effects upon the grazing habits of dairy cattle. (2, 3, 8, 9, 17).

Seasonal Composition of Pasture Grass

Hobbs et al. (9) reported that the dry matter of bluestem grass increased from 32.7 percent in the middle of May to 39.0 percent during the middle of July, and then decreased to 30.2

percent by the first week in September. The protein content was 8.97 percent in May, decreased to 6.77 percent in June and then increased up to 7.78 percent by the first week in September. Samples of grass taken in July, August and September were especially uniform in composition, the average content of protein and crude fiber being 7.75 percent and 31.24 percent, respectively. The ash content was quite uniform throughout the season, varying from 7.10 percent on June 25 to 8.32 percent on September 6. The nitrogen-free extract varied very little throughout the summer, the average content being about 52 percent.

The authors reported that the digestibility of the protein was 38.4 percent in June. They claimed the low digestibility of the protein was due to the low protein content in June. The digestibility of crude fiber was 64.2 percent, which, according to the authors, was at variance with the usual observation that crude fiber of early grass is highly digestible.

During July, August and September the digestibility of the dry matter, crude fiber and nitrogen-free extract varied only slightly, the averages being about 58 percent, 70 percent and 62 percent respectively. There was, however, a slight decrease of 1 to 2 percent from July to September in the digestibility of the dry matter, crude fiber and nitrogen-free extract.

Crampton and Farshaw (5) found that there was a progressive falling off of the nutritive value of pasture grass during the summer months and a return to that of spring grass with better herbage growing conditions in the fall. Dry matter,

nitrogen, cellulose and nitrogen-free extract showed a gradual decrease in digestibility as the season advanced. The increase of lignin in the summer was responsible for the decrease in digestibility.

A seasonal trend from high moisture and high crude protein to low moisture and low crude protein was reported by Lush (12) at Louisiana for White Dutch clover, Dallisgrass and Bermuda grass pasture. There was a corresponding increase in crude fiber and nitrogen-free extract, with little variation in the fat and ash content as the season advanced. Variations in the protein content were the least in the late summer.

Schutt, Hamilton and Selwyen (16), working in eastern Canada, found that the protein content of Meadow Foxtail and timothy grass increased from early to late season. They reported that the season of the year and the rate of growth are more important than the type of vegetation in influencing the protein and fiber content of monthly clipped pasture grass.

Grazing Habits of Dairy Cattle

Time Spent Grazing. It was reported by Atkeson, Shaw and Cave (1) that milk cows spend slightly less than half their time grazing while on good pasture in April. The grazing time on good pasture was 5.6 hours of a 11 hour and 40 minute period. Cows on a fair pasture of mixed brome grass and alfalfa grazed 6.5 hours, while on poor pasture of short wheat 7.3 hours were

required for the cattle to obtain their fill. These observations show that the cattle spent 31 percent more time grazing poor pasture than when grazing good pasture.

Dry cows and yearling heifers under 24 hour observations on a Balboa rye pasture spent 7 hours or 29 percent of the time grazing. On the basis of a 12 hour day and 12 hour night 4.3 hours or 36 percent of the daytime was spent grazing and 2.7 hours or 23 percent of the night time was spent grazing. In other words the cattle did about 63 percent of their grazing during the daytime and 37 percent during the night.

Bonsma (3) found that beef cattle in South Africa spent from 75 to 85 percent of their time between 8:00 a.m. to 5:00 p.m. grazing. No night observations were made during that study, but Johnston-Wallace (11) found that beef cattle did 60 percent of their grazing during the day and 40 percent at night on Kentucky blue grass pasture in New York. He reported that the average time spent grazing was 7 to 8 hours in a 24 hour period. Of this amount, 4.4 hours of grazing was done between 7:00 a.m. and 7:00 p.m., and 3.1 hours of grazing was done between 7:00 p.m. and 7:00 a.m. However, only 5 hours of the recorded time was considered as actual grazing time as some time was occupied in walking short distances or selecting herbage to be grazed. He reported that the cattle walked 2½ miles during the day as compared to ½ mile at night, which he claimed indicated more efficient grazing at night due to less distraction.

Hancock (8) at the animal research station Ruakura, New Zealand reported similar findings. He found that dairy cows graze on the average 410 minutes or just under 7 hours a day. However, when on scanty, but fresh pasture, cows will devote as much as 10 hours per day to grazing. The longest grazing time was reported in December, which is comparable to our May, followed by a sharp decline in the summer and a rise again in the fall. This trend, according to the author, shows that the time spent grazing is mainly determined by the quality of the grass, which usually deteriorates during the dry spell of the summer. In agreement with previous work, he found that dairy cattle do 60 percent of their grazing during the day and 40 percent during the night, or between the afternoon and mornings milking. According to Hancock (8) this brings out the importance of providing good pasture in sufficient amounts for night grazing. According to these findings he states that for every three acres of pasture needed during the day, 2 acres would be needed for night time grazing.

Hodgson (10) reported that, in western Washington, cows subjected to continuous grazing, spent on the average 7 hours and 19 minutes grazing during a period from 6:00 a.m. until dark. Cows subjected to rotational grazing spent 6 hours and 51 minutes grazing for the same period of time. As the grazing season advanced the average time spent grazing by the cows subjected to rotational grazing decreased from 6 hours and 54 minutes per day during the week of April 28 to 6 hours and 25 minutes per day during the week of September 8. During the

same period the average time spent grazing for cows subjected to unrestricted grazing increased from 5 hours and 39 minutes daily to 7 hours and 35 minutes daily. The shorter time expended in grazing, according to the author, indicates that the cows subjected to rotational grazing were able to obtain their needs with a smaller expenditure of energy than those grazing unrestricted.

Mosely, Stuart and Graves (13) reported that dairy cows in Montana on irrigated grass and sweet clover, grazed on the average 8.97 hours per day in June and 9.35 hours in August. Observations were made from 5:00 a.m. to 9:00 p.m. On a percentage basis, the cows grazed 56 percent of the time in June and 56.4 percent of the time in August. The feeding of supplements such as hay and grain decreased the time spent grazing proportional to the amount of supplement fed.

Seath and Miller (18) at the Louisiana Experiment Station found that the feeding of hay to cows on pasture reduced the grazing time very little. They reported that the difference of 40 minutes less grazing time for cows receiving hay seemed to be due to chance variation and not to the supplemental feed.

Seath and Miller (17) also found that when the atmospheric temperature averaged 85° F. and 86° F. for two consecutive days in September, dairy cows grazed only 1.9 hours and 1.8 hours, respectively, during the day-time and 6.5 hours and 6.2 hours, respectively, during the night. When the atmospheric temperature averaged 72° F. during the day the cattle increased their day-time grazing to 2.8 hours and decreased their night-time

grazing by 1.1 hours. On the 4th and 5th day the atmospheric temperature again averaged 72° F. and the cattle grazed on the average 4.5 hours during the day and 4.85 hours during the night. In spite of the decreased night grazing, the total time spent grazing for the 4th and 5th days was 9.2 hours and 9.5 hours, respectively. The day-time period included the time between 7:15 a.m. when the cows were turned on pasture until 2:35 p.m. when the cows were removed for milking. The night time period included the time after the night milking until 3:45 a.m. when the cows were brought into the barn for the morning milking.

Working at the North Dakota Experiment Station, Shepperd found that three Hereford steers averaged 8 hours and 15 minutes per day grazing on sweet clover pasture. These results were comparable to results obtained when the cattle were placed on a Sudan grass pasture.

Time Spent Grazing as Affected by Production. The butterfat producing ability of cows has little effect on the amount of time spent grazing according to Hancock (8). He found that a good producer, producing 510 pounds of butterfat grazed only 10 percent more time than a cow producing only 230 pounds of butterfat. It is apparent that the "boarder" cows consume a much greater share of the available feed than is required by their bodies for maintenance and production. He claimed that this strengthens the argument for continuous testing and culling of poor producers.

Time Spent Grazing as Affected by Heredity. Hancock (8) states that the amount of time dairy cattle spend grazing is

inherited. When sets of identical twins were used as experimental animals, the difference in grazing time within sets was slight, whereas the difference in grazing time between sets of twins was quite large.

Time Spent Grazing as Affected by Climate and Weather. The climate and weather have some effects upon the grazing habits of dairy cattle. Bonsma (3) stated that livestock are sensitive to climatic changes because these changes affect their vital physiological functions. Higher atmospheric temperatures cause an increase in body temperature and as a result an animal becomes less active and eats less in order to prevent overheating. Most cattle belonging to the exotic beef breeds will stop ruminating when the atmospheric temperature rises above 90° F., the result being that the animals suffer from undernourishment as soon as they experience difficulty in eliminating surplus heat from the body.

On rainy windy days Hancock (8) found that cows would walk to the fence farthest away from the direction of the wind. On very hot days it was found that the cows did considerably more walking than normally. He speculated that this was probably due to the discomfort of the cows.

Seath and Miller (17) showed that as the temperature decreased the time spent grazing increased during the day and decreased during the night.

Periods of Grazing. Atkeson, Shaw and Cave (1) reported four primary grazing periods during the day, the first period starting at 5:30 a.m. and lasting for two and one-half hours.

A second period began at about 10:00 a.m. and lasted from an hour to an hour and a half. The third period began between 12:30 and 1:00 p.m. and lasted for about two hours. The fourth daylight grazing period began about 6:00 p.m. and continued until about 8:30 p.m.

The first night grazing period started at about 9:30 p.m. and lasted for an hour and a half. The second period started about 1:00 a.m. and lasted until 3:30 a.m. During the day the herd tended to graze as a group, but at night more individual action was noted.

Hancock (8) found that dairy cows tended to have 3 or 4 grazing periods during the day and 2 or 3 grazing periods at night. As the days become shorter, the period of grazing following the afternoon milking become progressively shorter.

Seath and Miller (17) reported that the number of grazing periods during the day averaged 1.4, while at night the cattle grazed on the average 2.7 times. During each period of observation the cows spent their longest grazing period immediately after being turned into the pasture after milking. In the daytime, the early morning grazing was the only period of grazing of any consequence. Whenever a cow grazed a second or third time during the day it was a short period and usually in the shade of a tree or during a cloudy period.

The night grazing started off with a long period averaging 3.1 hours. The second period averaged 1.4 hours and the third period averaged 1.5 hours. The first night grazing period usually began at 5:45 o'clock, the second period started around

10:30 o'clock and the third period usually a little after midnight. The cows were removed from pasture at 3:30 a.m., otherwise there may have been more third and fourth grazing periods.

Hodgson (10) reported that cows on rotational grazing averaged 8.83 grazing periods daily as compared to 7.87 grazing periods for cows grazing unrestricted.

Rate of Grazing. According to Hancock (8) dairy cows graze at an average rate of 50 bites per minute with the rate being the highest at the beginning of each grazing period. No difference in the rate of grazing was noted between night and day grazing. It was calculated that dairy cows take on the average 23,500 bites during a 24 hour period with a range of 17,000 to 30,000 bites.

Time Spent Lying and Standing. Atkeson, Shaw and Cave (1) found that dairy cows lay down on the average 13 hours or 54 percent of a 24 hour period and spent 4 hours standing without grazing. Of this time 35 percent of the day and 80 percent of the night was spent lying down and 25 percent of the day and 4 percent of the night was spent standing or walking without grazing. Cows lay down on the average four times during the day on good pasture and only two times on poor pasture.

Hodgson (10) reported that cows would lay down on the average 3.13 times for a total of 3 hours and 18 minutes when rotational grazing was practiced, but only 2.38 times for 2 hours and 34 minutes when grazing unrestricted. As the season progressed the time spent lying down decreased for the cows grazing unrestricted and increased for the cows subjected to

rotational grazing. These observations are based on a daytime period from 6:00 a.m. to dark. For the same period of time the cows on rotational grazing stood, without grazing, for 1 hour and 8 minutes and the cows grazing unrestricted stood for 1 hour and 23 minutes.

Johnston-Wallace (11) found that cattle spend on the average 11 hours and 49 minutes of a 24 hour period lying down with an average of 8.6 periods of lying. These results are comparable to the findings of Schalk and Amadon (15) who found that cattle on dry feed spend on the average 11.17 hours of a 24 hour period lying down.

Time Spent Ruminating. Schalk and Amadon (15) reported that dairy cows spend 6.4 hours of a 24 hour period ruminating when on dry feed. About the same amount of time was spent ruminating when the cattle were standing as when they were lying down. The cows averaged 162 rumination periods in a 60 hour period. It required on the average 45.4 chews to remasticate a bolus.

Fuller (7) found that cows on dry feed spend on the average 8 hours and 17 minutes of a 24 hour period ruminating. It required 55 jaw movements per bolus to remasticate the regurgitated food. The average time required for deglutition and regurgitation to occur was 3.73 seconds and the average time required to remasticate a bolus was 53.9 seconds.

Three Hereford steers on sweet clover pasture averaged 7 hours of a 24 hour period ruminating according to Shepperd (19).

Hancock (8) states that he found cows ruminated for a period of time equal to 3/4 of the time spent grazing, providing the pasture was of good quality. Schalk and Amadon (15) reported that cows on pasture ruminated 30 times in 24 hours with an average of 26.1 boli per ruminating period. It required 39.11 chews per bolus which was 6 chews less than the number required when the cattle were on dry feed.

He also noted that young animals ruminate more rapidly and particularly champ their jaws faster than do older animals. The older animals ruminated more slowly and more deliberately, requiring a greater number of champs to reduce the forage to the desired consistency.

Pasture grass required less rumination time than dry forages. The act was shorter in duration, more rapid in execution and in the end the food was more finely comminuted.

Hancock also stated that any disturbance such as flies, mosquitoes, dogs, herd mates or other conditions to worry or frighten the animal will cause a cessation of the act of rumination. Readily available water was found to be conducive to rumination.

Water Requirements of Dairy Cattle

Water is vital to the well being of plants and animals, and without it life could not long endure. Life can be sustained longer in the absence of food than without water. Water constitutes about 70 to 80 percent of the animal body, it carries

digested food particles to the tissues and removes waste products from the tissues of the body. It aids in controlling body temperature by evaporation through the skin, and in dairy cattle it constitutes more than 87 percent of the milk.

According to Petersen (14) water for maintenance is proportional to the size of the animal, as are other nutrient requirements. Eckles (6) states that dry cows need not be watered more than once daily during the winter, but in the summer the consumption of water by cattle on maintenance rations is greater because of the increased evaporation from the skin. He stated that while cattle will thrive when watered only once a day, they relish it more often and will do better if water is readily available to them at all times.

Atkeson and Warren (2) found that dairy cattle drank more water during the day than at night. They state that the addition of a succulent feed to the ration decreased the amount of free water consumed, but the total water intake remained about the same. Cows in milk drank more water and drank more often than did dry cows.

Atkeson, Shaw and Cave (1) reported that milk cows on pasture drank on the average three or four times during the day with no apparent relationship to the quality of the pasture. Johnston-Wallace (11) found that beef cattle on Kentucky Blue grass pasture with a moisture content of 72 percent drank only once during the day and usually late in the afternoon.

EXPERIMENTAL PROCEDURE

Dry cows and pregnant heifers were used as experimental animals. The number of animals in the herd at one time ranged from 18 to 24. Three observations were made each week and data recorded for 1/3 of the animals each day of observation. This made one observation period each week for each animal in the herd. The animals under observation on any one day were allowed to mingle with the rest of the herd. The animals changed frequently due to the addition of new animals to the herd, removal of animals which were approaching freshening time or that were removed because of injury or other causes.

Weather recording equipment was placed in the pasture, the location of which was approved by Dr. A. B. Cardwell, Head of the Department of Physics, Kansas State College. Temperature, rainfall and average wind velocity were recorded. The wind direction was taken from readings made at the chemistry building on the campus of Kansas State College, located about four miles southeast from the grazing area.

The pasture consisted of 80 acres of native bluestem grass. The average annual rainfall for this area is 34.57 inches according to Cardwell and Flora (4). The average precipitation for June is 4.50 inches; July, 4.25 inches; August, 3.89 inches and 3.44 inches for September. These averages are based on data recorded at Manhattan from 1858 to 1942 inclusive.

The average temperature for the month of June is 74.5° F.;

July, 79.5° F.; August 77.5° F. and 69.3° F. for September. Average daily maximum temperatures of over 100° F. have been recorded.

The average wind velocity or wind movement for June is 6.17 miles per hour; July, 5.18 miles per hour; August 5.28 miles per hour and in September 6.02 miles per hour.

Grass samples were taken about every two weeks and a chemical analysis for protein, fat, ash, fiber, moisture, nitrogen-free extract and carbohydrates was made on each sample. Random samples of grass were obtained from 10 or 12 locations throughout the pasture by throwing a hoop and collecting all the grass within its diameter. Samples were also obtained for chemical analysis from within wire cages which had been placed at random throughout the pasture. The grass within each cage was clipped to a height of 1½ to 2 inches each time a sample was obtained; therefore, each succeeding sample was young new grass.

The first data were collected June 27, 1949, the last data were recorded September 9, 1949. Observations started at 6:00 a.m. and ended at 6:00 p.m. One 24 hour observation was made August 7 and three 48 hour observations were made on July 24 and 25, August 23 and 24 and September 6 and 7. A flashlight was used at night to facilitate writing and for checking the animals.

For convenience throughout the rest of this paper all day-time periods will include the time from 6:00 a.m. to 6:00

p.m. and all night-time periods will include the time from 6:00 p.m. to 6:00 a.m. unless otherwise stated.

During the day the following data were recorded for each individual animal under observation for that particular day:

1. Time spent grazing
2. Time spent lying down
3. Time spent standing
4. Time spent ruminating
5. The number of times each animal drank
6. Rate of grazing (bites per minute)
7. Rate of rumination and cud chewing (time to regurgitate, remasticate and reswallow a bolus; chews per bolus).

The following observations were made on the entire herd each day observations were made:

1. Pattern of grazing
2. Location of grazing
3. The direction of grazing

During the night the time spent ruminating was not recorded because of the inability to see exactly when an animal started or stopped rumination. However, the rate of rumination and cud chewing was recorded.

Contour maps of the pasture with location markers were used to record the location of the cattle. A portion of these maps are shown in the appendix, Plates I, II, III, IV and V.

Animals of similar breeding were observed on different days, in so far as was possible, to determine the affect of

heredity on the amount of time spent grazing.

In conjunction with the foregoing observations the social behavior of the animals was recorded.

It was hoped that the distance traveled daily by each animal could be recorded, but because of the large area and the dense brush in the gullies, no practical means of recording the distance walked was devised.

EXPERIMENTAL RESULTS

For convenience and simplicity the results of this experiment will be discussed under seven headings, as follows:

Weather Observations
Composition of the Grass
Time Spent Grazing
Time Spent Lying and Standing
Time Spent Ruminating
Drinking Habits
General Observations.

Weather Observations

Temperature. All daily temperature averages are based on readings made each 2 hours from 6:00 a.m. until 6:00 p.m., except for the average temperature for June 27 when temperature readings were not made until 10:00 a.m., hence, the explanation for a mean temperature of 92° F. for that day.

The average day-time temperature was 83° F. for the 14 days the cattle were observed in July. The maximum temperature recorded for July and for the entire summer was 103° F. on July 20, the average temperature for that day being 95° F. The lowest mean temperature for July was 74° F. recorded on July 29.

The month of August had a mean daily temperature of 79° F. for the 15 days that the cattle were observed. The warmest day was August 12 which averaged 88° F.; and August 31 the temperature average 67° F.

In September the temperature took a considerable drop, the average for the four days of observation being 69° F. On the warmest day, September 2, the mean temperature was 77° F. and on the coolest day, September 7, the mean temperature was 63° F. The weather was wet and cloudy the first week in September; this was the probable reason for the low temperature at this time of the month.

The coolest time during the day was usually at 6:00 a.m. During the first two hours there was quite a sharp rise in temperature, averaging from 8 to 10° F. Occasionally the rise was greater. By 10:00 a.m. the rise in temperature became more gradual with the peak reached by 2:00 p.m. on most days. Occasionally the peak was reached by noon but often the peak in temperature was not reached until 3:00 or 4:00 p.m.

The average night temperature was 80° F. for July 24 and 25, and for the night of August 7 the mean temperature was 76° F. As the summer progressed the average night temperature

became cooler. The nights of August 23 and 24 the mean temperature was 67 and 69° F., respectively. The night temperature averaged 67° F. on September 6 and 57° F. on September 7.

During the night-time period the warmest time was at 6:00 p.m., with a gradual decline in temperature until 6:00 a.m. The coolest temperature recorded during night observations was 55° F. on September 7. The highest temperature was 92° F. recorded at 6:00 p.m. July 25.

The mean temperatures indicate that although the days were warm, the nights were relatively cool and better suited to the comfort of the cattle.

A more detailed study of the temperature ranges may be found in Tables 1 and 2 of the Appendix.

Rainfall. The first rain which was recorded fell June 28, the day following the first observation. Two and one hundreths inches of rain were recorded. During July there were four days on which rain was recorded while data was being collected. The rainfall varied from a maximum of 0.41 inches, recorded July 6, to only a trace on July 27. The total rainfall for July was 1.46 inches, which was considerably under the long time average of 4.25 inches for July as reported by Cardwell and Flora (4).

Again in August, the total rainfall of 1.58 inches was considerably less than the long time average of 3.89 inches (4). Rain fell during four days of observation.

Rain fell during six of the first nine days in September for a total of 2.22 inches which was more than one-half the amount of the long time average rainfall for the entire month.

The total amount of rainfall for the entire period from June 27 to September 9 was 7.275 inches, with at least a trace of rain being recorded on eighteen different days.

Table 3 of the Appendix contains a detailed account of the rainfall for the period of observations.

Wind Velocity. By recording the wind velocity it was hoped that some information could be gained about how the wind affected the grazing habits of dairy cattle.

The long time average wind velocity for June is 6.17 miles per hour according to Cardwell and Flora (4). On June 27 the wind averaged 9 miles per hour from a westerly direction.

The average wind velocity for the days on which observations were made in July was 7 miles per hour. On July 13 there was very little air movement the average velocity being about 2 miles per hour. On July 20 an average velocity of about 13 miles per hour was recorded, the maximum for the month. The wind on that particular day was hot and from a south to a southwest direction all afternoon. The maximum temperature of 103° F. was also recorded on that day.

The average wind velocity for the days observations were made in August dropped to 6 miles per hour, with a range from 3 to 9 miles per hour. The velocity of the wind for the four days observations were made in September varied from 4 miles per hour to about 7 miles per hour.

These averages are a little higher than the monthly averages reported by Cardwell and Flora (4), but they follow the same general trend as the long time average for this part of the state.

The average wind velocity at night was usually considerably less than the average velocity for the day. The maximum velocity recorded at night was 10 miles per hour on July 25. The minimum velocity was 1 mile per hour recorded August 24. The average for the seven nights observations were made was about 5 miles per hour.

A more detailed report of the wind velocity may be found in Table 4 of the Appendix.

Wind Direction. The direction from which the wind was blowing was recorded every hour from 6:00 a.m. to 6:00 p.m. for day observations and from 6:00 p.m. to 6:00 a.m. for night observations. Generally the wind was from a southerly direction the greater part of the summer.

For a more detailed study of the wind direction, Tables 5 and 6 of the appendix may be consulted.

Composition of the Grass

A study of Fig. 1 shows that, on a moisture free basis, the nitrogen-free extract and fiber remained fairly constant; the ash increased from 6 to 10 percent; while the protein decreased from about 9 to about 4 percent. The carotene decreased from 22 mg per 100 grams of grass to about 4 mg per 100 grams of grass. However, Fig. 2 shows that the composition of the grass as being grazed was somewhat different. The moisture content decreased from 67 to 43 percent; the protein increased from 3 percent in June to 3.5 percent in July and then decreased to 2.5 percent in

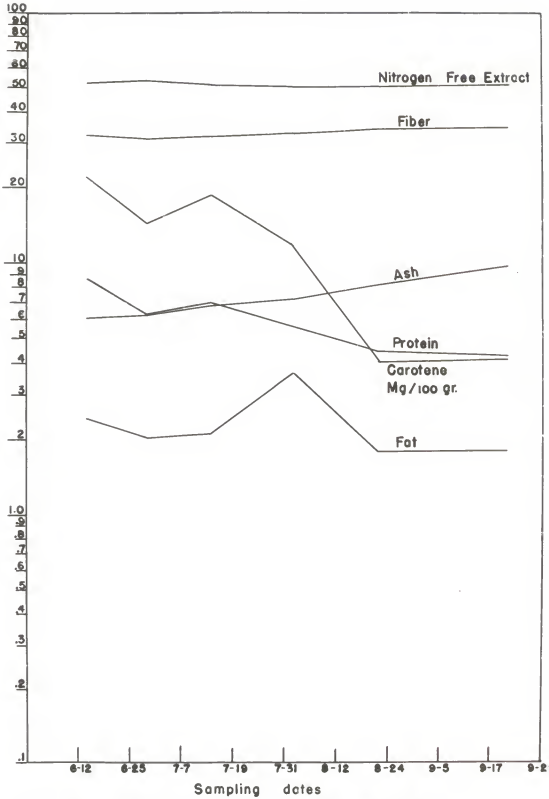


Fig. 1 Composition of grass moisture free basis.

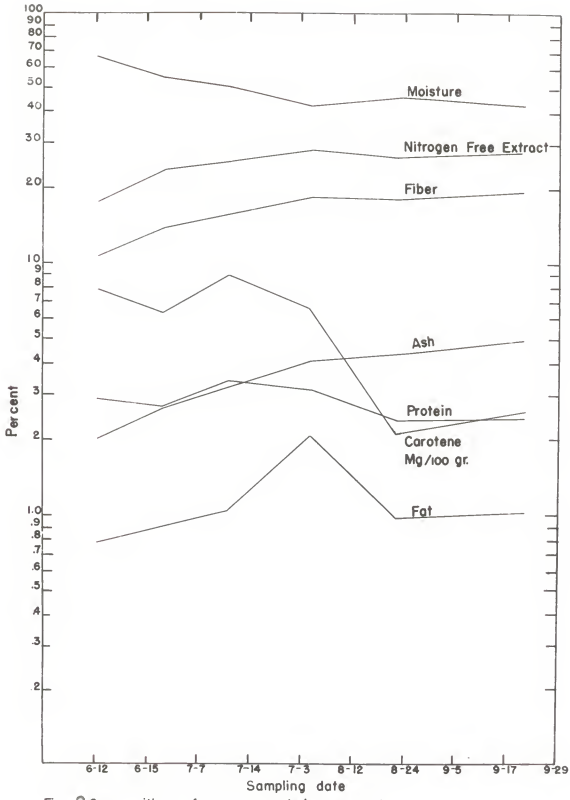


Fig. 2 Composition of grass as being grazed.

September. The carotene decreased from 8 to 3.5 mg per 100 grams of grass. As the season progressed, the nitrogen free extract increased from 17 to 28 percent; the fiber increased from 11 to 20 percent, and the ash increased from 2 percent to 5 percent.

The fat content in both cases remained fairly constant except for a sharp rise on August 2, for which no explanation can be offered.

It is shown in Fig. 3 that the composition of the grass obtained from within the cages differs considerably from the composition of the grass which was available for grazing.

As the season progressed the moisture content of the clipped samples from within the cages increased from 50 percent on July 17 to 66 percent on September 21. The protein decreased from 4 percent to slightly under 3 percent; the nitrogen-free extract decreased from 25 to 16 percent; the fiber decreased from 16 to 11 percent and the ash remained nearly constant at 3.5 percent.

The carotene fell off considerably until September 21. The sample at this time contained 12.00 mg of carotene per 100 grams of grass, or an increase of 10.00 mg per 100 grams over the sample of grass obtained August 23. During the early part of September there was an ample amount of rainfall for rapid growth, hence the probable explanation for the increase in carotene content.

As the season progressed, the grass as being grazed decreased in moisture, protein and carotene and increased in ash, fiber

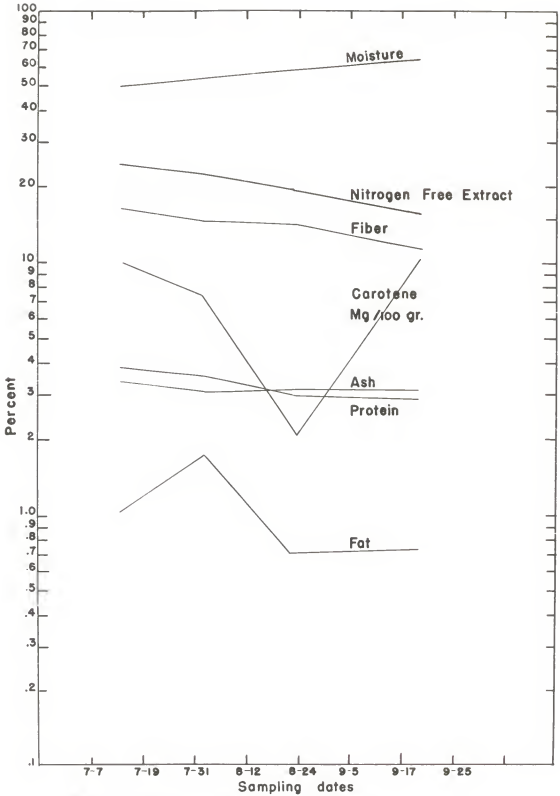


Fig. 3. Composition of grass within cages.

and nitrogen-free extract. The grass within cages increased in moisture content, and decreased in nitrogen-free extract, fiber, ash and protein. The carotene decreased until early September and then increased sharply.

A detailed analysis of the grass is shown in Table 7 of the Appendix.

Time Spent Grazing

Time Spent Grazing as Affected by Temperature. The results of this experiment show that there is an apparent relationship between the time spent grazing and the atmospheric temperature. It was found that as the atmospheric temperature decreased the time spent grazing increased (Figs. 4 and 5).

A study of Figs. 6, 7, and 8 show that as there was a decrease in average daily atmospheric temperature there was almost always an increase in the time spent grazing. When the atmospheric temperature increased the time spent grazing decreased as a general rule. Each group of cattle observed followed the same general pattern. The cattle in group III (Fig. 8) showed this relationship more precisely than did the cattle in either group I or II (Figs. 6 and 7). However, the relationship did exist in these two groups.

During the first week of observations the mean daily temperature was 88° F. and the average time spent grazing for all cattle was 3.5 hours during the day-time. The mean daily temperature dropped to 80° F. the week of August 1 and the grazing

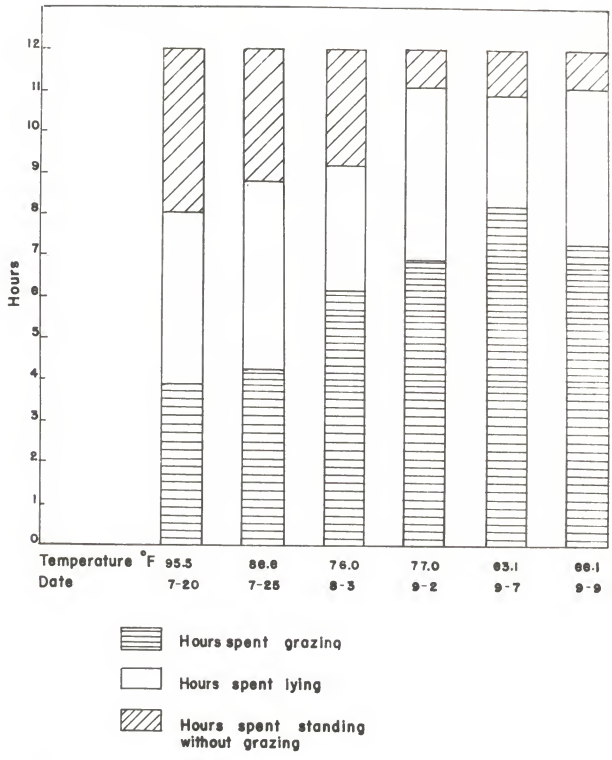


Fig. 4. Hours grazing, lying and standing as affected by temperature.

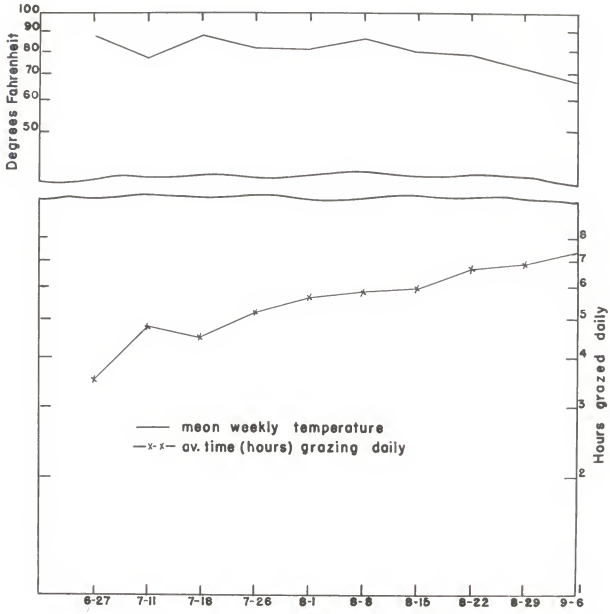


Fig. 5. Av. Hours grozing doily, for all cattle as affected by mean temperature.

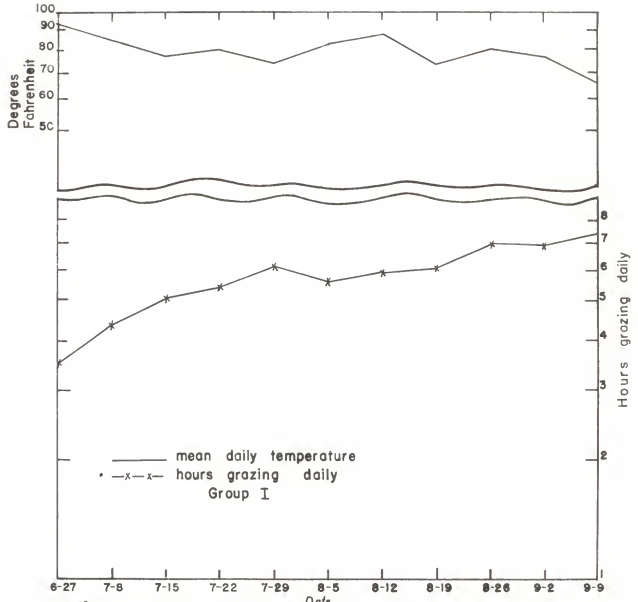


Fig.6. Hours grazing 6:00 A.M. to 6:00 P.M. as affected by temperature.

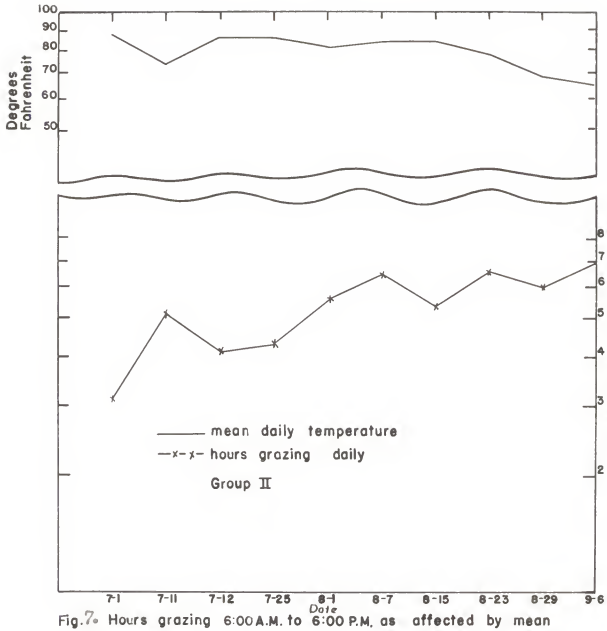


Fig. 7. Hours grazing 6:00 A.M. to 6:00 P.M. as affected by mean temperature.

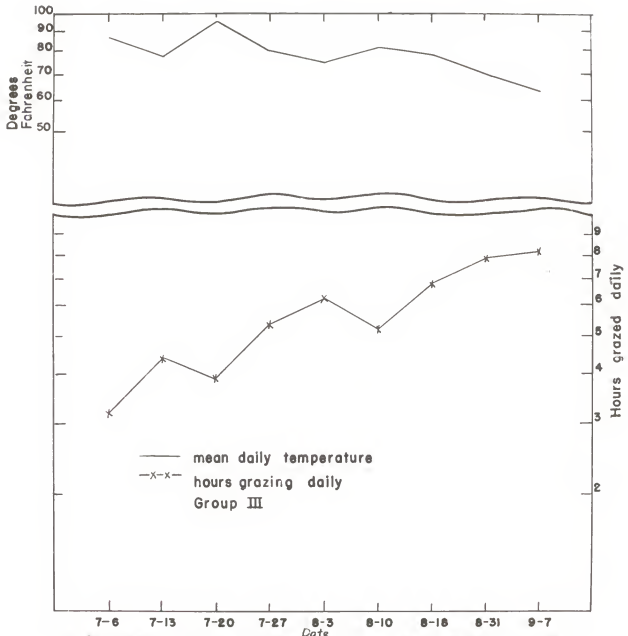


Fig. 8. Hours grazing 6:00 A.M. to 6:00 P.M. as affected by mean temperature.

time increased to 5.7 hours during the day-time. During the last week of observations, the mean daily temperature was 62° F. and the cattle grazed an average of 8 hours during the day-time.

On July 20 the temperature reached 103° F. and the cattle grazed a little less than 4 hours during the day-time, none of which occurred between 1:00 and 5:30 p.m. The two observation days previous to July 20, the temperatures averaged 78° and 86° F., respectively, and the cattle grazed 5 and 4.5 hours, respectively. On July 22 the temperature again dropped to 78° F. and the cattle grazed almost 6 hours. Fig. 9, and Tables 8 and 9 of the Appendix show these relationships in more detail.

Table 10 of the Appendix shows that during the latter part of July the cattle grazed about 4 hours in the day-time and about 3.3 hours of the night or approximately 7.3 hours of the 24 hour period. As the season progressed the amount of time spent grazing increased up to as high as 8.1 hours during the day-time, while the night-time grazing increased only slightly at mid-season and then declined till the end of the season (Fig. 10). At the end of the season when the peak in day-time grazing was reached and the night-time grazing was about 3.2 hours, the cattle grazed as much as 11.3 hours or a little more than 47 percent of the 24 hour period. This again indicates that as the daily atmospheric temperature becomes cooler dairy cattle will utilize more of their day time for grazing than they will when it is too warm.

For the entire period of observation cattle in group I

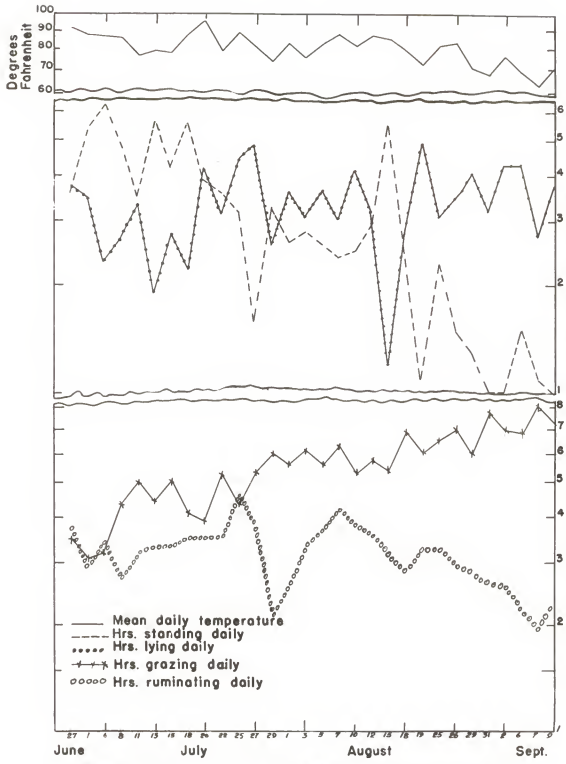
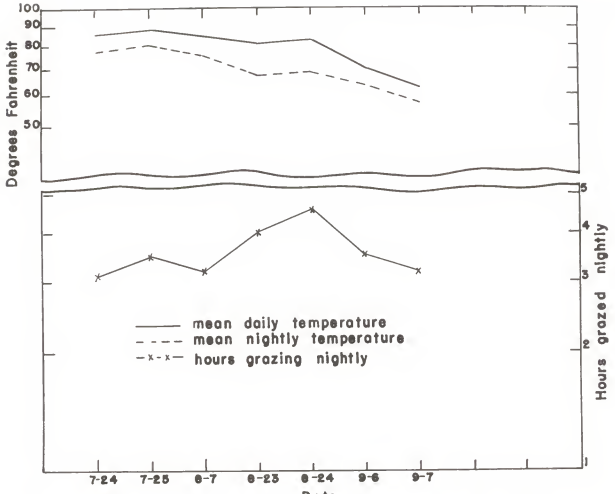


Fig. 9. Utilization of time, 6:00 A.M. to 6:00 P.M., for dry cows and heifers on bluestem pasture, as affected by mean daily temperature.



10.

Fig. Hours grazing 6:00 P.M. to 6:00 A.M. as affected by mean daily and mean night temperatures.

(Table 9) averaged 47 percent of their time grazing. Cattle in group II and III utilized about 44 percent and 47 percent of their time grazing, respectively. All cattle observed spent on the average about 46 percent of the day-time grazing with a range of 29 percent the first week to 62 percent of their time at the end of the season.

Hancock (8) claimed that the time spent grazing was also affected by the composition of the grass. One might speculate then, that the temperature alone is not the only factor affecting the amount of time cattle will spend grazing, but that the composition and digestibility of the grass should be taken into consideration.

A detailed study of Fig. 11 shows that the cattle had about 3 or 4 grazing periods during the day-light hours and 1 or 2 during the night.

It is difficult to give the exact times of the grazing periods because they changed throughout the summer. However, in early summer the first grazing period of the day-light hours was from about 5:00 a.m. to 9:30 a.m. As the season progressed, this period of grazing moved up to 6:30 or 7:00 a.m. and continued until 10:30 or 11:00 a.m. This later start of the first grazing period may have been due to the later time which the sun rose as the season progressed. The second grazing period started about two hours after the end of the first period and usually lasted from 1½ to 3 hours, depending upon the time of the season, being longer at the end of the summer. In the early part of the summer, the third period did not start until about 5:30 p.m. and

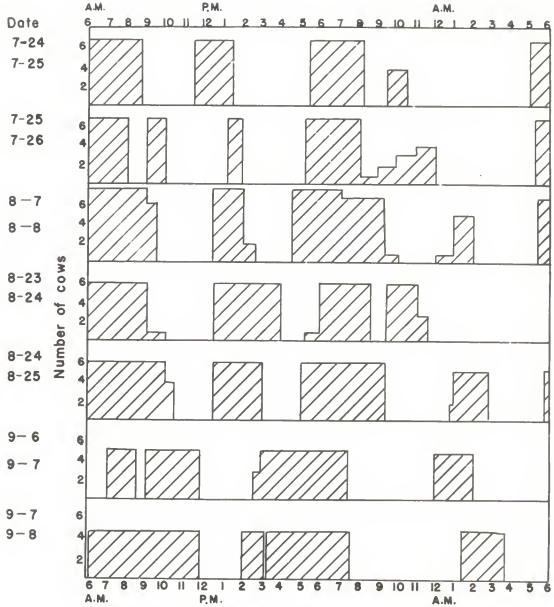


Fig. 11 Grozing periods for 24 hour period for dry cows ond heifers on bluestem posture.

lasted for 2 or 3 hours. Later in the season the third day-light grazing period was underway from 3:30 to 4:30 p.m. and lasted until 8:00 to 8:30 p.m.

In the early part of the summer there was little grazing observed during the heat of the day, between the hours from 1:30 to 4:30 p.m. As the season progressed and the days became cooler, more and more of this time was utilized for grazing (Fig. 11).

There was usually one period of grazing during the night. Occasionally in the early part of the summer there were two periods of grazing during the night. These periods came early in the night, usually before midnight. Toward the end of the season the night grazing period usually started about midnight and lasted for 2 to 2½ hours. The cattle were never observed to graze between the hours of 3:30 a.m. and 5:00 a.m. This possibly may be the ideal time to do the morning milking so that the cows may be turned back out to pasture to obtain their fill before the heat of the day, and the flies begin to cause them too much discomfort which might cut down their grazing efficiency.

The Effect of Heredity on the Grazing Habits of Dairy Cattle. It was believed that the amount of time which cattle graze might be influenced by their inheritance. To study the effect of heredity, cows and heifers of similar breeding were observed on different days.

A study of Table 11 of the Appendix reveals that the difference in time spent in various activities between sets of half sisters while on pasture was, in many cases, less than was the

difference within sets of half sisters. This would indicate that heredity did not play an important role in determining the amount of time that these cattle spent in the various activities while on pasture. However, definite conclusions should not be made from these observations because of the few number of comparisons which were made and because of the lack of closeness in the relationship of the animals used for comparison. Hancock (8) reported that a close correlation existed in time spent grazing within sets of identical twins, but did not exist between sets of identical twins, indicating that the time spent grazing is affected by heredity.

Rate of Grazing. The rate of grazing or the number of bites per minute taken by the cattle did not change materially as the season progressed. For the entire summer all cattle observed took, on the average 32 bites per minute. Cattle in group I averaged 21 bites per minute on July 15 and 41 bites per minute on September 9, but the cattle in groups II and III did not show so great a variation. This information is presented in Table 12 of the Appendix.

In the early part of the season when the cattle grazed approximately 30 percent of the time, an average of 32 bites per minute would necessitate the taking, on the average of 7,000 bites for a 12 hour period to gather the grass which they consumed. At the end of the season when the cattle were grazing 10 to 11 hours of a 24 hour period, it would require approximately 21,000 bites per day to gather the grass which was eaten by the cattle. It is apparent from these data that cattle expend vast

amounts of energy daily in gathering herbage.

Table 13 of the Appendix shows that the rate of grazing at night was slightly higher than during the day time. For the seven nights on which observations were made, the cattle averaged 34 bites per minute as compared to 29 bites per minute for the seven days immediately preceeding the night-time observations. This was probably due to less distraction at night and therefore the cattle grazed more efficiently.

Areas of Close Grazing. On August 15, the areas which had been closely grazed were shaded on a contour map of the pasture (Fig. 12). A study of this map shows that the cattle preferred the slopes for grazing rather than the top of the hills, with the exception of the area east of location marker 1, and the area around the gate. The close grazing around the gate may have been due to the salt block which was an attraction for the cattle in this area.

It will also be noted that the cattle grazed the slopes facing the southeast in preference to slopes facing in other directions. This may suggest that the cattle were taking advantage of the prevailing south winds in this area during the summer (4).

Pattern of Grazing. Grazing patterns for the group were taken periodically to determine whether a rather constant pattern prevailed.

A study of Fig. 13 shows that although some cattle did not graze in any particular position, while others maintained a

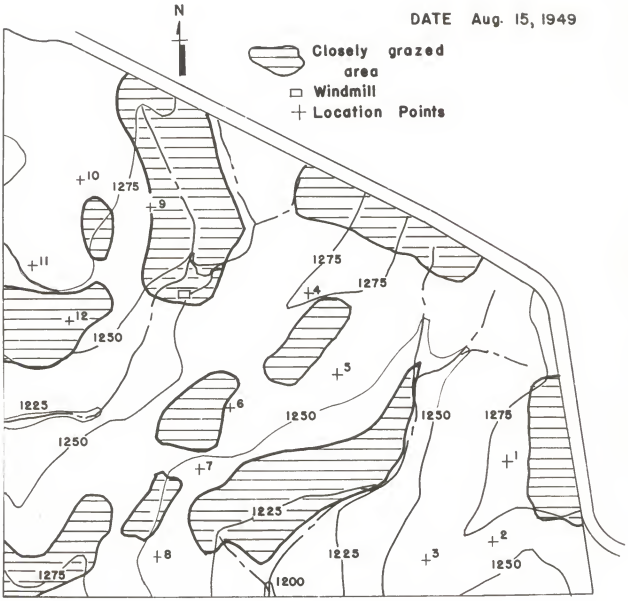


Fig. 12. Areas of close grazing.

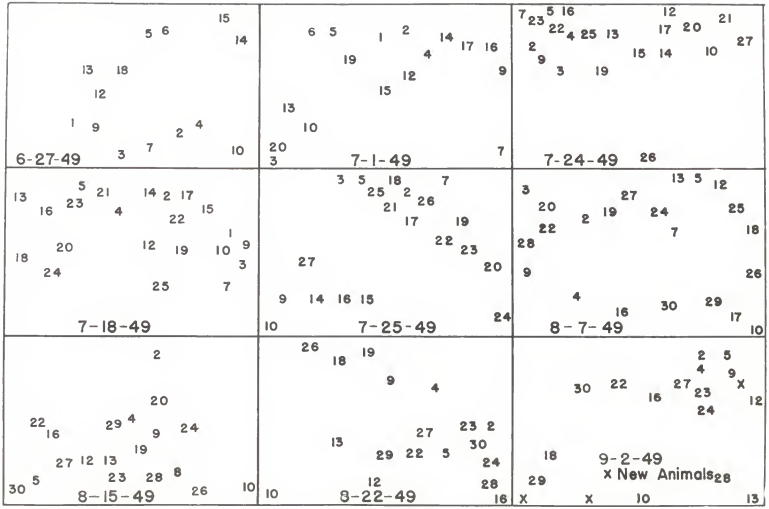


Fig. 13. Pattern of grazing of dry cows and heifers on bluestem pasture.

definite relationship with the rest of the herd most of the time.

It is interesting to note that cow No. 10, an Ayrshire, usually grazed more or less by herself, back of and to the side of the herd. Cow No. 9, a Jersey, was seldom found to be in the middle of the herd, but preferred to graze on the flanks. Cow No. 3, a Guernsey preferred the back row while grazing. A Holstein, No. 5, was found to be in the front of the group while grazing. Cow No. 13, an Ayrshire, was usually found to be near the front and to the left of the herd, although occasionally she was observed to be in the middle of the group.

It was also noticed that cows No. 14 and No. 15, two Holsteins, often grazed close together, but with no established relationship to the rest of the cattle. These cows were half sisters, but this observation did not apply to other half sister pairs.

The relationship of one cow to another, or of one cow to the rest of the herd, may have been more pronounced if the same cows had remained in the herd for the entire summer, or if new cows had not been added to the herd.

Direction of Grazing with Respect to Direction and Velocity of the Wind. It has been reported that the direction and velocity of the wind affects the direction in which the cattle graze. The data obtained from these observations were not accurate enough to make definite conclusions regarding the effect the wind had on the direction of grazing. However, a study of Fig. 14 shows that there is a tendency for the cattle to graze into the wind more than with the wind. Many times the cattle

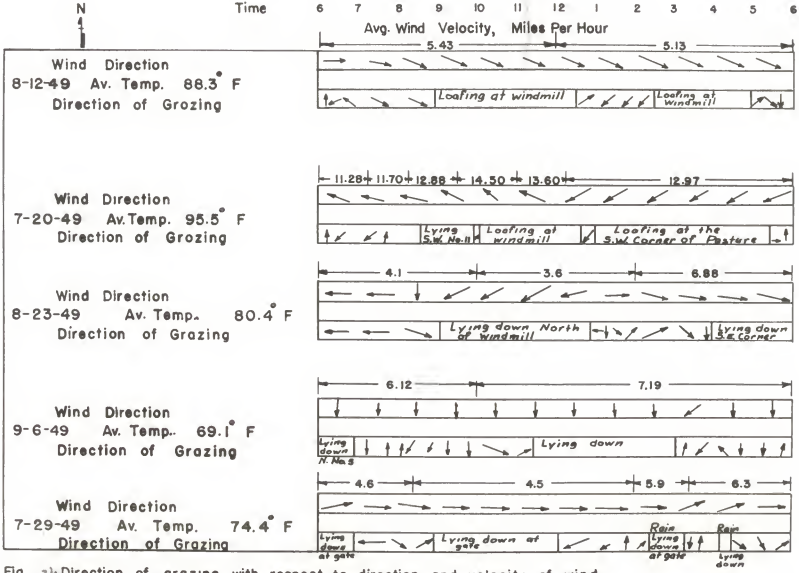


Fig. 14 Direction of grazing with respect to direction and velocity of wind.

would have to change direction of grazing because of a fence.

The velocity of the wind appeared to have little effect on the direction of grazing, but more often adverse weather conditions would cause the cattle to change direction when grazing or to seek shelter in a direction away from which the wind was blowing.

It was noted that during frequent showers on July 29, (Figs. 14 and 15), the cattle would walk with their tails to the wind. The herd was lying down near the gate as it started to rain at 12:05 p.m. The cattle immediately headed for the brush south of the windmill, a direction away from which the rain was coming. They remained in the brush until the rain ceased at 1:00 p.m. They returned to the gate and were lying down, when again at 3:15 p.m. a second shower drove them toward the south end of the pasture. The rain stopped in a few minutes and the cattle returned to the area around the gate. At 4:30 p.m. a third shower drove the herd into the brush southeast of the gate. They remained in the brush until about 5:00 p.m. By this time the shower had changed to a slow drizzle and the cows returned to grazing in a south to southeast direction with the wind from a northeast direction.

On other occasions the cattle were observed to walk to the brush in a direction away from which the rain was coming. The cows were never observed to lie down during a rain.

On July 20 the average wind velocity was 13 miles per hour. The wind blew from a northwest direction all morning and then changed to a southwest direction in the afternoon. The mean

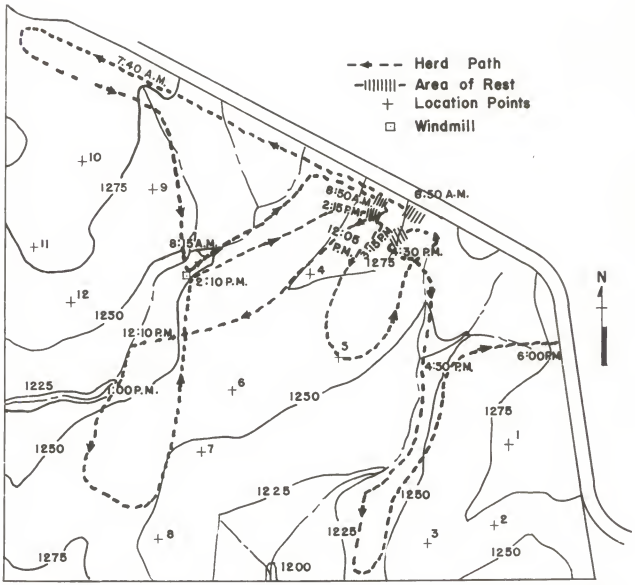


Fig. 15 Area and direction of herd movement, 6:00 A.M. to 6:00 P.M., 7-29-49

temperature was 95° F., the warmest day the cattle were observed.

During the morning, the cattle grazed in the northwest portion of the pasture. As the wind shifted to the southwest, the cattle walked to the southwest corner of the pasture and loafed the rest of the afternoon. Figure 14 and Fig. 16 of Plate I of the Appendix show this observation.

Plate I, Figs. 16 and 17 further shows that the amount of walking done during the day is not appreciably affected by the temperature. Although the distance traveled could not be measured accurately, it was about the same on July 20 when the temperature rose to 103° F. as it was on one of the cooler days, August 31, with possibly a slight edge to the distance traveled on the coolest day. However, it must be kept in mind that on July 20 the cattle grazed 3.9 hours of the day as compared to 7.9 hours of the day on August 31. This indicates that much of the walking done on the hot day was probably because of the discomfort of the cattle.

A study of Plate II, Figs. 18 and 19, Plate III, Figs. 20 and 21, Plate IV, Figs. 22 and 23 and Plate V, Figs 24 and 25, of the Appendix reveals that the cattle did considerably more walking during the daylight hours than they did during the night, although on the night of August 23 and 24 a considerable amount of walking was done after dark. This may have been due to the threatening of rain with a considerable amount of thunder and lightning during the early part of the night.

Time Spent Lying and Standing

During the day time cattle spend a certain amount of time standing, not including the time spent standing while grazing. At the beginning of the season the cattle spent considerably more time standing (without grazing) than they did at the end of the season. This would be expected, since more time was spent in grazing late in the season and therefore there would be less time for the cattle to loaf (Table 9 and Fig. 9).

For the first half of the observed grazing season, through August 5, the cattle spent 34 percent of their time standing (without grazing) as compared to only 14 percent of the time during the second half of the grazing season. For the entire season the cattle stood on an average of 26 percent of the time.

Data in Table 10 and Fig. 26 show that the cattle spend more time standing during the day time than at night, but, with the exception of the first 24 hour period of observation, the difference was not great. For the seven days of observation, it was found that the cattle stood on the average 22 percent of the time, and for the seven nights immediately following the seven days 17 percent of the time. It will also be noted that as the season progressed the total time spent standing for a 24 hour period decreased rather markedly.

It is interesting to note that the time spent lying down remained about the same from the beginning of the season to the end of the season, with some variations from day to day. A more

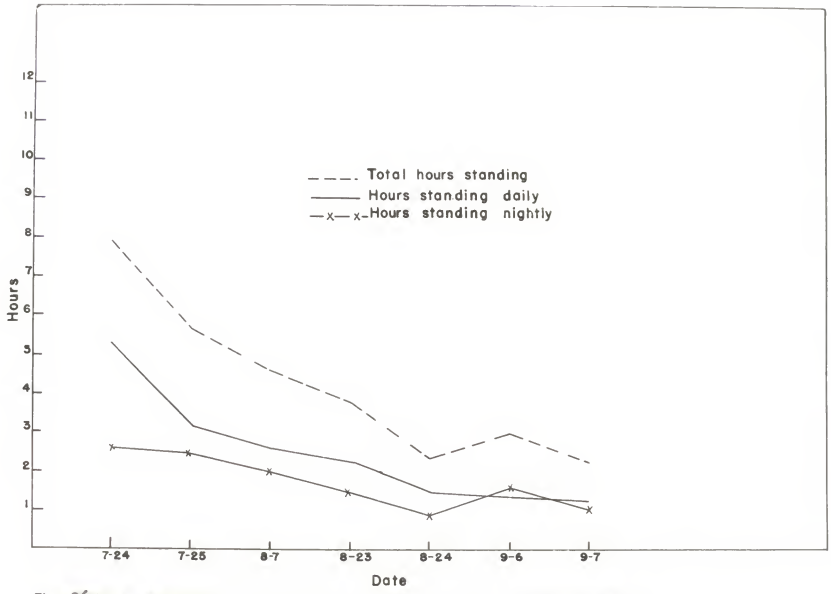


Fig. 26 Hours standing (without grazing) day, night and for 24 hour period.

thorough study of Fig. 9 will show, for any one particular day, that as the amount of time spent standing increased the time spent lying down decreased. It can also be seen that as the season progressed there is a gradual decline, with day to day variations in the time spent standing but very little or no decline in the time spent lying down. The fact that the cattle spent approximately the same amount of time lying down throughout the summer would indicate that a certain amount of rest is required for the continued well-being of the animal.

On the average, for the seven 24 hour observation periods the cattle spent 28 percent of the daytime lying down and 56 percent of the night-time lying down. The average time spent lying down for the 24 hour period was 42 percent. Table 10 and Fig. 27 show that as the percent of time spent lying down during the day decreased the time spent lying down during the night increased so that the total amount of time spent lying down remained fairly constant for a 24 hour period throughout the grazing season.

Time Spent Ruminating

The data in Table 9 show that dry cows and heifers on blue stem pasture ruminate, on an average, 27 percent of the time. It would be expected that since the grazing time increased as the season progressed, the rumination time would also increase. However, this was not the case (Fig. 5). During the first

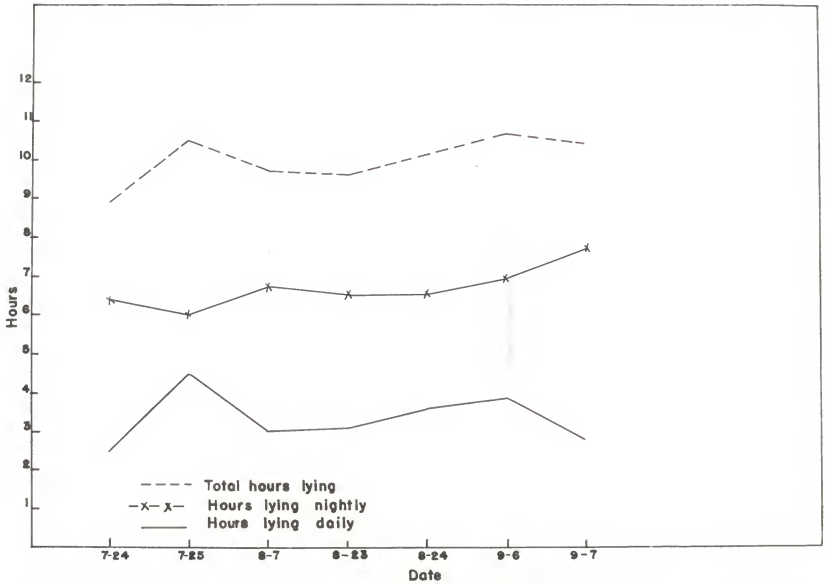


Fig. 27 Hours lying down day, night and for 24 hour period.

week of observations, the cattle ruminated on the average 28 percent of the time as compared to 18 percent of the time during the last three days of observation, even though the time spent grazing had increased from 29 percent of the time early in the summer to more than 60 percent late in the season. Whether the cattle did not ruminate enough at the close of the season to sufficiently prepare their food for digestion and absorption is not known as digestion trials were not conducted.

The fact that the cattle spent less time ruminating at the end of the season even though the time spent grazing increased, would again indicate that dairy cattle need a certain amount of time daily for complete rest.

The amount of time spent ruminating at night was not recorded because of the inability to see exactly when a cow would start and stop the act of rumination, although the rates of the various acts of rumination were recorded.

Table 11 shows that on the average, dry cows on bluestem pasture remasticate a bolus or cud 49 times, requiring, on the average, 50 seconds to chew each bolus. It required approximately 4 seconds to re-swallow one bolus and to regurgitate the following bolus. All phases of rumination remained fairly constant throughout the summer. Fuller (7) reported that cows on dry feed made 80 to 95 jaw movements per bolus. Schalk and Amadon (15) found that two cows on pasture averaged about 40 chews per bolus.

Data in Table 13 of the Appendix show that during the night

all of the rates of the various phases of rumination were slightly increased over the corresponding day-time rates. This would perhaps indicate that cattle were more efficient during the night than through the day-time, possibly due to less distraction.

It was noted that any distractions such as dogs, other cattle, horses and other people would cause the act of rumination to cease, momentarily at least.

Apparently the temperature did not materially influence the amount of time spent ruminating. Figure 5 shows that even though the temperature was 95° F. on July 20, which was the warmest time of the day, the cattle spent about 31 percent of their time ruminating, with a good share of this time occuring between 1:30 and 5:30 p.m.

Drinking Habits

Water is essential to the well-being of an individual and its easy availability is vitally important to dairy cattle. One well, located somewhat near the center of the pasture was the only source of drinking water for the cattle, with the exception of an occasional pool of water in the intermittent streams. Once in awhile an animal was observed drinking from one of these pools.

At the well there were three tanks so arranged that water was pumped directly into one tank and could overflow into the second and so on into the third tank. It was interesting to

note that the cattle preferred to drink from the second and third tanks even though the water was not so fresh or cool as was the water in the first tank.

On the average, the cattle drank 1.7 times during the day-time throughout the summer with twice daily being the most frequent number of times reported. On two of the hot days, June 27 and July 20, with mean temperatures of 93° F. and 95° F., the cattle drank on the average 2 and 2.5 times, respectively. On three relatively cool days, July 29, August 18 and August 22, with mean daily temperatures of 72°, 76° and 78° F., respectively, the cattle drank on the average 1.4, 1.4 and 1.1 times, respectively. This would indicate that on warmer days cattle need more water than on cooler days.

The hours when most drinking occurred during the day-time are shown in Fig. 28. No drinking was observed between the hours of 8:00 p.m. and 5:00 a.m. on any of the seven nights observations were made.

The cattle did not drink during the 24 hour period from 6:00 a.m. September 7 to 6:00 a.m. September 8. One cow 267A, an Ayrshire, did not drink for a 48 hour period, from 6:00 a.m. September 6 to 6:00 a.m. September 8. A probable explanation for these long periods when no drinking was observed may have been due to the considerable amount of rain which fell during that period and the cattle were able to obtain enough water from eating wet grass to satisfy their desire.

It was also noted that mornings when there was considerable dew on the grass, the cattle would delay their drinking until

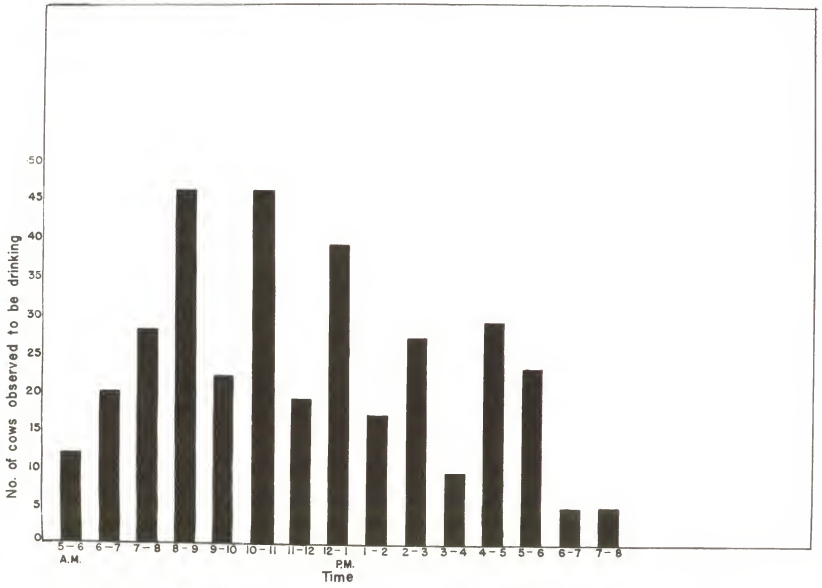


Fig. 28. Drinking periods for dry cows and heifers on bluestem pasture

late in the morning. When there was no dew, and the grass was extremely dry, the cattle usually drank early in the morning.

General Observations

As a general rule the cattle grazed as a group. Occasionally an animal or two would leave the rest of the herd to graze by themselves, but usually only for short periods of time. During the night there was more individual action than was observed during the day. As the season progressed the cattle had a tendancy to fan out and graze a wider area than was noted earlier in the summer.

The cattle were easily distracted from their normal routine by various disturbances. The main distraction was a herd of cattle which were driven past the pasture each morning and evening. If the experimental herd was near the road which borders the pasture on the east and north, they would go up to the fence and follow the herd as far as was possible. A beef herd in the pasture to the west of the experimental pasture was also a main source of distraction.

An occasional dog would interrupt the cattle, but only momentarily. A man on horseback often passed through the pasture causing the cattle to cease grazing for a short time. However, neither dogs nor horses were as distracting as were other cattle in the vicinity of the experimental herd.

On one occasion a cow calved while in the pasture. This

cow tried vainly to go off by herself, but the rest of the herd would not permit her to leave the group, but followed her continually. When the cow calved the rest of the cattle bothered the calf and her dam to the extent that it was necessary for the attendant to drive them away with considerable difficulty. This would indicate that the privacy of a clean, well bedded box stall would be more desirable for calving than in the pasture where the rest of the herd can interrupt the normal calving processes.

Strangely enough, the passing of automobiles or the presence of automobiles in the pasture did not disturb the cattle.

The cattle were very docile and with the exception of one cow, an Ayrshire, No. 10, the attendant in the pasture was able to walk up to any cow in the pasture after having been there for a few days. Incidently, cow No. 10, was the animal which was always fighting the rest of the cows or new animals as they were brought into the herd.

No one cow in particular was observed as being the leader of the group. However, cow No. 13, an Ayrshire, cow No. 21, a Jersey, and cow No. 10, an Ayrshire, led off to grazing and to water more frequently than any of the rest of the cattle.

The cattle spent much time walking through the brush and often on warm days they would stand or lie in the brush.

DISCUSSION

Pasture is one of the most important crops in the United

States and more than 5½ million acres of land were devoted to pasture in 1947.

In studying the grazing habits of dairy cattle, it was found that as the season progressed the moisture content of the grass being grazed decreased. The ash, fiber and nitrogen-free extract increased, with a decrease in protein and carotene. Lush (12) of Louisiana obtained results comparable to these for White Dutch clover, Dallisgrass and Bermuda grass.

On the moisture free basis the ash, fiber, fat and nitrogen-free extract remained fairly constant, but the protein and carotene showed a decrease. Hobbs et al. (9) at Oklahoma report results comparable to these findings, except they reported an increase in protein from June to September.

In the early part of the observed grazing period, the cattle grazed approximately 34 percent of the day-time and 26 percent of the night-time. These results are comparable to the findings of Atkeson et al. (2) who reported that yearling heifers on Balboa rye grazed 36 percent of the day-time and 23 percent of the night-time, and with results of Hancock's (8) work in New Zealand. Johnston-Wallace (11) reported similar results for beef cattle grazing Kentucky blue grass in New York.

As the season progressed, the temperature decreased, and the time spent grazing increased up to more than 60 percent of the day-time, while the time spent grazing at night remained fairly constant. Seath and Miller (18) at Louisiana found that as the atmospheric temperature decreased the day-time grazing increased

and the night-time grazing decreased. The total grazing time during cool weather was greater than the total grazing time in hot weather. Hodgson (10) reported that as the season progressed the time spent grazing from 6:00 a.m. to dark increased from 5.6 hours in April to 7.6 hours in September. Mosely et al. (13) also reported an increase in grazing time from June to August.

The cattle were observed to have 3 or 4 grazing periods during the day-light hours and 1 or 2 during the night, which were comparable to the findings of Atkeson et al. (2) and Hancock (8). Seath and Miller (18) reported 1 or 2 grazing periods during the day-time and 2 or 3 during the night. However, it should be pointed out that the day-time period was from 7:15 a.m. to 2:35 p.m. and the night-time period from the time the cattle were turned out after the night milking to 3:45 a.m. Hodgson (10) reported 7 or 8 grazing periods from 6:00 a.m. to dark.

The results of this experiment showed that heredity had little influence upon the grazing habits of the dairy cattle under observation. Hancock (8) claimed that the difference in time spent grazing between sets of identical twins was considerably more than was the difference within sets of identical twins. Therefore, he concluded that the time spent grazing was influenced by heredity.

The cattle being observed grazed on an average of 32 bites per minute during the day-time with little variations throughout the season. The night-time rate of grazing was slightly higher

than was the rate of grazing for the corresponding days. Hancock (8) reported that dairy cattle graze at the rate of 50 bites per minute. He noted little difference in the rate of grazing between night and day grazing.

No other reference to areas of close grazing has been found, but as a result of this experiment it was found that the cattle grazed the southeast slopes in preference to the tops of the hills or bottom lands. Whether the botanical composition of the grass was different to account for this is not known. It may have been due to the prevailing south winds, but the evidence is not conclusive.

It was found that on stormy days the cattle would seek shelter in a direction away from which the wind was blowing. Hancock (8) also noted this while observing the grazing habits of dairy cattle.

More walking was observed during the day-time than during the night-time which is comparable to the results obtained by Johnston-Wallace (11).

The cattle averaged 28 percent of the day-time and 56 percent of the night-time lying down or a total of 10.1 hours of a 24 hour period. They stood on an average of 25 percent of the day-time and about 17 percent of the night-time. Atkeson et al. (2) found that the total time of a 24 hour period spent lying down for yearling heifers continuously on pasture was 13 hours. The time spent standing at night was only about 4 percent of the time. However, this conclusion was based on a 14 hour day and a 10 hour night. Johnston-Wallace (11) and Schalk

and Amadon (15) found that the cattle they observed spent about 50 percent of a 24 hour period lying down.

The cattle ruminated 27 percent of the day-time which is comparable to the findings of Shepperd (19). Fuller (7) reported cows on dry feed ruminated about 33 percent of the time. Schalk and Amadon (15) reported cows on dry feed ruminated approximately 27 percent of the time.

It required 49 chews and 50 seconds to remasticate a bolus, which was about 10 chews per bolus more than reported by Hancock (8), and 4 seconds to reswallow and regurgitate a bolus.

The cattle did not cease ruminating even at a temperature of 103° F. which is contradictory to the findings of Bonsma (3) who claimed exotic beef cattle stopped ruminating when the temperature reached 90° F.

The cattle were observed to drink on an average of 1.7 times during the day-time. Johnston-Wallace (11) reported beef cattle on blue grass pasture drank only once during the day. Atkeson et al. (2) reported that milk cows on pasture drank 3 or 4 times during the day.

The fact that the cattle being observed drank from the two tanks of water which were not as fresh or cold as was available may suggest that work could be done which would determine the optimum temperature of drinking water for dairy cattle.

SUMMARY AND CONCLUSIONS

For the entire period of observation from June 27, 1949 to

September 9, 1949 the temperature, wind direction and wind velocity were average for this section of the state. The rainfall was considerably less than the average for this area.

On a moisture free basis the nitrogen-free extract and fiber remained fairly constant, the ash increased, the protein and carotene decreased. The composition of the grass as being grazed was somewhat different. The nitrogen-free extract, fiber and ash increased, the carotene decreased and the protein decreased as the season progressed. The fat remained fairly constant in both cases.

Dry cows and pregnant heifers on bluestem pasture were observed to spend on an average 46 percent of their time grazing, 28 percent of their time lying down, and 26 percent of their time standing during the day-time.

During the early part of the season the cattle grazed about 30 percent of the day-time. As the season progressed and the temperature decreased the time spent grazing increased to more than 60 percent of the day-time.

The time spent grazing at night showed a slight increase at mid-season with a decline at the end of the season. The cattle grazed on an average of 27 percent of the night-time.

The cattle had 3 or 4 grazing periods during a 24 hour period, with 1 or 2 of them occurring during the night. No grazing was observed between 3:30 a.m. and 5:00 p.m.

Heredity seemed to have little influence on the amount of time the cattle spent in various activities, although definite

conclusions should not be made from these observations.

The rate of grazing remained fairly constant throughout the season, averaging 32 bites per minute. The rate of grazing at night was slightly higher than during the day.

The cattle grazed the southeast slopes in preference to the tops of the hills and bottom lands.

The cattle grazed in somewhat of a definite pattern with some animals preferring certain locations within the herd.

The cattle showed a tendency to graze into the wind except during adverse weather conditions.

The cattle stood (without grazing) on an average of 26 percent of the day-time and 17 percent of the night-time.

On the average, 28 percent of the day-time and 56 percent of the night-time was spent lying down.

The cattle spent 27 percent of the day-time ruminating, requiring 49 champs and 50 seconds to remasticate a bolus, with 4 seconds to swallow and regurgitate.

The cattle drank on an average 1.7 times during the day-time. The cattle were never observed to drink between 8:00 p.m. and 5:00 a.m. They drank more often on warm days than on relatively cool days.

The cattle generally grazed in a group, they were easily distracted, and spent a considerable amount of time walking and standing in the brush.

ACKNOWLEDGMENTS

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APPENDIX

EXPLANATION OF PLATE I

Fig. 16. Area and direction of herd movement.
6:00 a.m. to 6:00 p.m.
July 20, 1949
Mean temperature 95° F.

Fig. 17 Area and direction of herd movement.
6:00 a.m. to 6:00 p.m.
July 31, 1949.
Mean temperature 67.8° F.

PLATE I

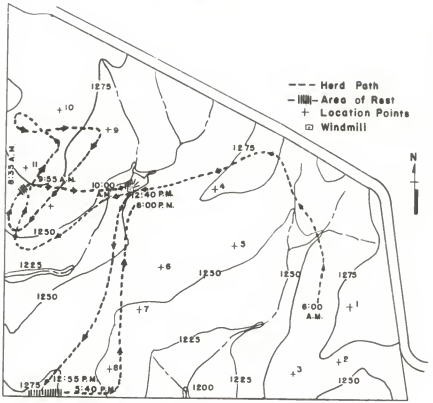

Fig. 16

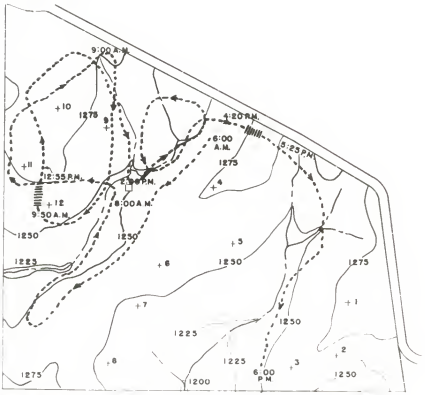

Fig. 17

EXPLANATION OF PLATE II

Fig. 18. Area and direction of herd movement.
6:00 a.m. to 6:00 p.m.
July 24, 1949.

Fig. 19. Area and direction of herd movement.
6:00 p.m. to 6:00 a.m.
July 24 and 25, 1949.

PLATE II

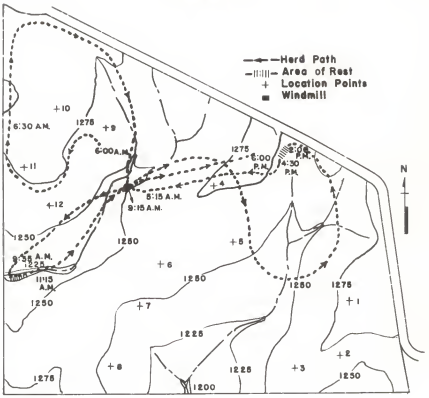

Fig. 18.

Fig. 19.

EXPLANATION OF PLATE III

Fig. 20. Area and direction of herd movement.
6:00 a.m. to 6:00 p.m.
August 7, 1949.

Fig. 21. Area and direction of herd movement.
6:00 p.m. to 6:00 a.m.
August 7 and 8, 1949.

PLATE III

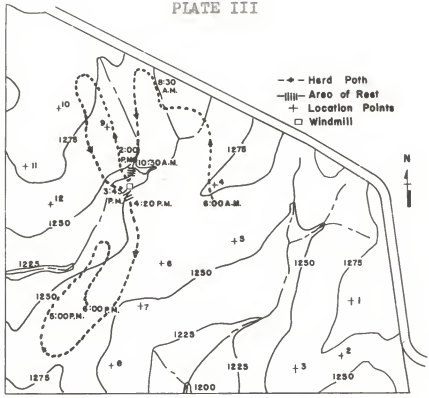

Fig. 20.

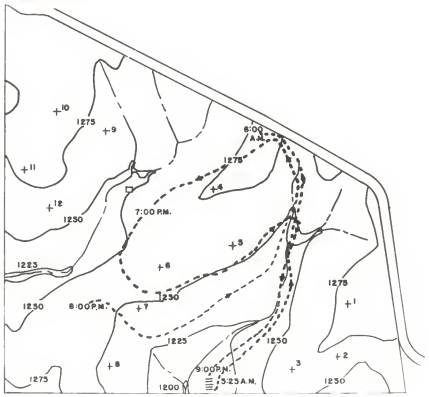

Fig. 21.

EXPLANATION OF PLATE IV

Fig. 22. Area and direction of herd movement.
6:00 a.m. to 6:00 p.m.
August 23, 1949.

Fig. 23. Area and direction of herd movement.
6:00 p.m. to 6:00 a.m.
August 23 and 24, 1949.

PLATE IV

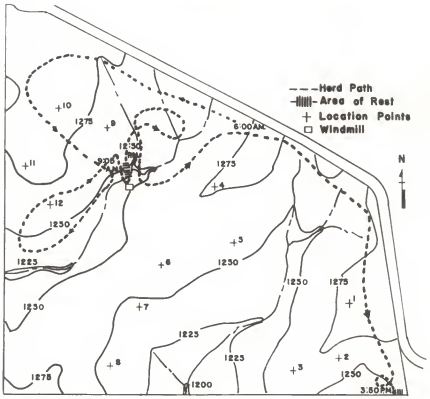

Fig. 22.

Fig. 23.

EXPLANATION OF PLATE V

Fig. 24. Area and direction of herd movement.
6:00 a.m. to 6:00 p.m.
September 6, 1949

Fig. 25. Area and direction of herd movement.
6:00 p.m. to 6:00 a.m.
September 6 and 7, 1949.

PLATE V

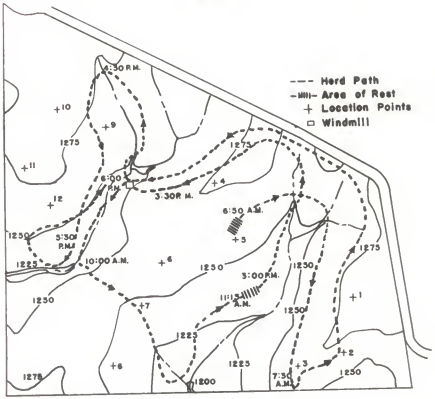

Fig. 24.

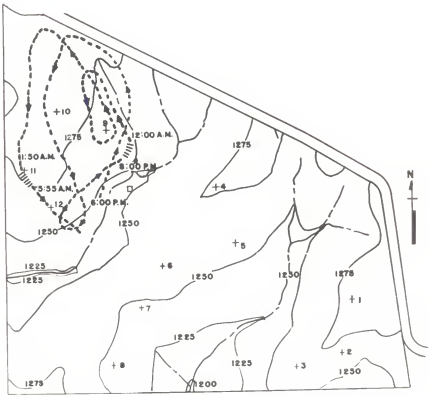

Fig. 25.

Table 1. Daily temperature in degrees fahrenheit.

Date	Time							
	A.M.			Noon	P.M.			
	6	8	10	12	2	4	6	Mean
6-27-49	-	-	88	92	96	95	92	92.6
7-1-49	74	80	88	94	96	96	93	88.1
7-6	72	81	86	91	94	95	92	87.3
7-8	74	83	85	90	93	92	84	85.8
7-11	70	74	76	78	80	80	76	76.3
7-13	62	71	80	84	86	89	81	79.0
7-15	64	70	74	81	84	84	82	77.0
7-18	70	78	88	94	98	98	92	88.3
7-20	81	89	96	101	103	103	96	95.5
7-22	64	71	79	87	86	88	82	79.5
7-24	71	81	88	92	94	92	88	86.5
7-25	75	83	90	92	94	95	92	88.8
7-27	74	76	77	81	82	88	88	80.8
7-29	70	70	80	78	77	76	70	74.4
8-1-49	69	90	83	89	89	86	81	83.8
8-3	54	68	78	80	83	84	85	76.0
8-5	62	73	83	88	91	92	88	82.4
8-7	70	78	87	94	95	92	89	86.4
8-10	70	72	76	88	90	93	88	82.4
8-12	74	80	88	93	98	97	92	88.3
8-15	68	75	83	89	92	92	86	86.4
8-18	69	72	80	86	86	91	73	79.5
8-19	64	67	72	75	78	79	71	72.5
8-22	54	66	76	82	84	84	80	78.0
8-23	60	68	82	86	91	90	86	80.4
8-24	58	70	82	89	92	91	86	81.1
8-26	66	74	84	90	92	88	83	82.4
8-29	60	64	72	80	--	--	78	70.5
8-31	56	56	62	75	80	76	70	67.8
9-2-49	54	66	73	74	87	86	82	77.7
9-6	61	62	63	66	76	80	76	69.1
9-7	62	62	62	68	64	64	62	63.4
9-9	51	56	65	72	74	76	70	66.1

Table 2. Night temperatures in degrees fahrenheit.

Date	Time P.M. 6	8	10	Midnight 12	2	A.M. 4	6	Mean
7-24-49	88	82	80	78	76	74	75	79.0
7-25	92	86	81	79	79	78	75	81.4
8-7-49	89	91	77	75	73	72	70	76.7
8-23	86	72	67	66	63	61	58	67.5
8-24	86	74	69	67	64	63	62	69.3
9-6-49	76	70	66	66	64	64	62	66.9
9-7	62	60	58	56	56	56	55	57.5

Table 3. Rainfall data - Hill Pasture June 27-September 9, 1949.

Date	Time recording made A.M.	Time recording made P.M.	Amount inches	Total for month
6-28-49	7:45		2.01	2.01
7-6-49	7:30		.41	
7-7	8:00		.21	
7-22	5:55		.22	
7-27	6:15		.09	
	9:15		Trace	
		1:45	Trace	
7-29	6:20		.045	
		2:00	.43	
		3:20	.01	
		6:00	.05	1.465
8-10-49	6:00		Trace	
	8:00		.01	
8-12	6:00		.05	
8-14	8:00		.44	
8-18	6:15		.39	
		6:00	.14	
8-19	6:00		.57	
8-31	9:30		.08	1.68
9-2-49	10:00		Trace	
	1:30		Trace	
9-3	8:30		.81	
9-6	6:00		1.14	
	10:00		.05	
	12:00 N.		.02	
9-7		2:15	.12	
		6:00	.06	
9-8	5:00		Trace	
9-9	6:30		.02	2.22
	Total for summer			7.375

Table 4. Average wind velocity - hill pasture - June 27-September 9, 1949.

Date	Minimum	Maximum	Daily ave. miles/hr.	Monthly ave. miles/hr.	Nightly ave. miles/hr.
6-27-49	7.60	10.93	9.38	9.38	
7-6-49	4.33	7.3	5.48		
7-8	3.38	4.0	3.69		
7-11	3.25	4.91	4.08		
7-13	2.86	2.86	2.86		
7-15	4.45	5.73	5.12		
7-18	6.00	6.93	6.38		
7-20	11.28	14.50	12.84		
7-22	3.68	4.98	4.33		
7-24	7.08	7.08	7.08		4.50
7-25	10.88	10.88	10.88		10.33
7-27	10.82	14.60	12.32		
7-29	4.53	6.29	5.32	7.11	
8-1-49	6.40	9.62	8.62		
8-3	2.20	3.50	2.87		
8-5	2.96	4.83	3.89		
8-7	5.70	5.70	5.70		4.18
8-10	3.82	13.30	8.88		
8-12	5.13	5.43	5.28		
8-15	1.40	4.15	2.98		
8-18	3.68	5.85	4.91		
8-19	7.60	8.84	8.22		
8-22	3.88	5.43	4.65		
8-23	3.60	6.86	4.86		1.40
8-24	5.38	8.10	6.61		1.11
8-26	5.30	11.19	8.25		
8-29	4.28	4.28	4.28		
8-31	6.28	11.00	8.43	6.02	
9-2-49	4.20	10.17	7.68		
9-6	6.12	7.19	6.65		5.68
9-7	6.78	6.53	6.65		4.72
9-9	4.20	4.20	4.20	6.25	

Table 5. Wind direction - Hill Pasture - June 27 to September 9, 1949.

Date	Time												
	A.M.						Noon	P.M.					
	6	7	8	9	10	11	12	1	2	3	4	5	6
6-27	W	WSW	WNW	WNW	WNW	WSW	W	W	SW	WNW	W	W	W
7-1	WNW	WNW	NW	NW	NW	SW	SW	SW	SW	WSW	SW	SWW	SWW
7-6	E	S	S	SSW	S	S	SE	SE	SE	SE	SE	SE	SE
7-8	E	NE	ENE	ENE	E	ENE	ENE	E	ENE	ESE	SEE	ESE	E
7-11	ENE	E	E	E	E	E	E	E	E	ENE	ENE	NE	NE
7-13	N	NW	N	E	SSW	N	S	ENE	SSW	S	SSE	S	S
7-15	NE	NE	NE	NE	NE	SE	E	ENE	ENE	E	E	E	E
7-18	WNW	NW	NWW	NWW	NWW	WNW	W	WSW	SSE	SSE	SSE	SE	SE
7-20	NW	WNW	WNW	NW	NW	SW	SSW	SSW	SSW	SSW	SSW	SSW	S
7-22	S	E	E	E	E	E	ESE	ESE	E	E	E	ESE	ESE
7-24	S	SE	S	S	SE	SE	SE	SW	SW	SW	SW	SW	SW
7-25	SW	W	W	W	W	WNW	W	W	WSW	W	SW	WSW	SW
7-27	WNW	NW	NW	NW	NW	NW	NW	SW	SSW	S	SE	SSE	SSE
7-29	ENE	E	ESE	E	E	E	E	E	ENE	NE	ENE	E	NE
8-1	WSW	W	W	WSW	W	W	W	NW	NNW	WNW	NNE	N	NNE
8-3	W	W	N	E	ENE	ENE	ESE	ESE	E	E	E	E	E
8-5	W	SSW	SW	SW	SW	SW	SW	SE	SE	SE	SE	SE	SE
8-7	W	W	W	W	SW	SW	SE	SE	SE	SE	SE	SE	SE
8-10	S	SSW	SSE	SSW	S	SSW	SW	SSW	S	SW	SSW	S	S
8-12	E	E	ESE	SE	SE	SE	SE	SE	SE	SE	SE	SE	SE
8-15	E	E	ENE	E	E	E	E	ENE	E	E	E	E	E
8-18	--	S	S	S	S	S	SW	SW	SW	WSW	SW	S	S
8-19	E	--	NE	NE	NE	NE	NW	NW	NW	NW	NW	N	NE
8-22	NE	E	ESE	SE	SE	SE	ESW	SSW	SSW	SSW	SW	SW	SW
8-23	W	W	S	SW	SW	SW	WSW	E	SE	ESE	ESE	SE	ESE
8-24	E	E	E	E	SE	SE	SE	S	SE	SE	SE	SE	SE
8-26	NW	NW	NW	NW	W	W	W	WSW	S	SE	SE	SE	SE
8-29	NW	W	W	SW	W	W	W	SW	SW	W	SW	W	WSW
8-31	N	S	SW	S	S	S	NW	NW	NW	NW	NW	N	N
9-2	W	W	W	W	SW	W	SW	SE	SE	SE	SE	SE	SE
9-6	S	S	S	S	S	S	S	S	S	SSW	S	S	S
9-7	E	E	SE	SE	SE	SE	SE	SE	SE	SE	SE	SE	SE
9-9	NE	NE	S	S	S	S	E	E	E	E	E	E	E

Table 6. Wind direction - Hill Pasture. Night observations.

Date	Time P.M. 6	7	8	9	10	Midnight 11	12	A.M. 1	2	3	4	5	6
7-24	SW	SW	SW	SW	SW	WSW	W	WSW	W	W	W	W	SW
7-25	SW	SW	SW	WSW	W	WSW	W	W	W	W	W	W	W
8-7	SE	SE	SE	SSE	SSE	S	S	S	S	S	S	S	S
8-23	ESE	E	SE	SE	SE	ESE	E	SE	E	E	E	E	E
8-24	SE	SE	E	E	ESE	E	SE	SE	SE	S	S	--	E
9-6	S	S	S	S	S	SSE	S	SE	SSE	S	S	ESE	E
9-7	SE	SE	SE	SE	SE	SE	SE	SSE	SSE	S	SSE	S	S

Table 7. Composition of grass as being grazed.

Date: 1949	Protein	Fat	Fiber	Moisture	Ash	N F E	CHO	Carotene mg/100gr
				percent				
6-13	2.91	0.79	10.84	67.10	2.01	17.35	28.19	7.95
6-29	2.77	0.90	14.04	55.73	2.70	23.86	37.90	6.42
7-14	3.41	1.03	15.74	51.37	3.33	25.12	40.86	9.08
8-2	3.16	2.09	18.64	43.51	4.07	28.53	47.17	6.78
8-23	2.38	0.97	18.28	47.33	4.40	26.64	44.92	2.11
9-21	2.43	1.03	19.55	43.22	5.01	28.76	48.31	2.58
	Composition of grass, moisture free basis.							
6-13	8.7	2.4	32.8		6.0	52.5	85.3	24.1
6-29	6.3	2.0	31.6		6.1	53.9	85.6	14.5
7-14	7.0	2.1	32.4		6.8	51.7	84.1	18.6
8-2	5.6	3.7	33.0		7.2	50.5	83.5	12.0
8-23	4.5	1.8	34.7		8.3	50.5	85.2	4.0
9-21	4.3	1.8	34.4		8.8	50.6	85.0	4.6
	Composition of grass from within cages.							
7-14	3.88	1.05	16.27	50.67	3.38	24.75	41.02	9.95
8-2	3.60	1.70	14.80	54.18	3.13	22.53	37.33	7.45
8-23	3.00	0.71	14.33	59.38	3.12	19.46	33.89	2.52
9-21	2.94	0.73	11.26	65.00	3.16	16.89	28.15	10.29

Table 8. Average time spent grazing daily for all cattle on observation as compared to the weekly mean temperature.

Week of	Mean temp.	Hours grazing daily	Percent time grazing
6-27*	88.4	3.5	29.5
7-11	77.4	4.8	40.3
7-18	87.8	4.5	37.6
7-25	81.3	5.2	43.1
8-1	80.6	5.7	47.7
8-8	85.7	5.9	48.8
8-15	79.5	6.0	50.2
8-22	77.9	6.8	56.5
8-29	72.0	6.9	57.7
9-6	66.2	7.4	62.1

*Includes July 1, July 6 and July 8.

Table 9. Daily utilization of time of dairy cattle on bluestem pasture for a 12 hour daytime period from 6:00 a.m. to 6:00 p.m.

Date	Grazing Hr.	Grazing %	Lying Hr.	Lying %	Standing Hr.	Standing %	Ruminating Hr.	Ruminating %
				Group I				
6-27	3.5	29.1	3.8	32.1	4.6	38.8	3.7	30.7
7-8	4.4	36.6	2.7	22.8	4.9	40.6	2.7	22.7
7-15	5.1	41.8	2.8	23.6	4.2	34.6	3.3	27.1
7-22	5.4	44.7	3.1	25.5	3.6	29.9	3.5	29.1
7-29	6.1	50.5	2.6	22.0	3.3	27.5	2.1	18.4
8-5	5.6	46.9	3.7	30.8	2.6	21.8	3.7	31.3
8-12	5.9	48.8	3.2	26.9	2.9	24.4	3.6	29.9
8-19	6.0	50.0	4.9	41.3	1.1	8.9	3.3	27.5
8-26	7.0	58.6	3.5	29.1	1.5	12.3	2.9	24.4
9-2	6.9	57.4	4.3	36.1	0.8	6.5	2.6	22.3
9-9	7.4	61.4	3.7	30.8	0.9	7.8	2.3	19.2
Av.	5.7	47.8	3.5	29.2	2.8	23.0	3.1	25.7
				Group II				
7-1	3.1	25.3	3.5	29.4	5.4	45.3	2.9	24.7
7-11	5.1	42.2	3.4	28.7	3.5	29.1	3.2	26.5
7-18	4.1	33.9	2.2	18.7	5.7	47.4	3.5	29.6
7-25	4.3	35.6	4.5	37.8	3.2	26.6	4.6	37.2
8-1	5.6	46.8	3.7	30.9	2.6	22.8	2.6	21.8
8-7	6.4	53.6	3.0	25.0	2.4	21.5	4.2	35.4
8-15	5.3	43.9	1.2	9.7	5.6	46.3	3.1	25.7
8-23	6.5	54.4	3.1	26.0	2.3	19.5	3.3	27.5
8-29	6.0	50.0	4.1	33.8	1.3	9.4	2.8	23.3
9-6	6.8	56.5	4.3	36.4	1.5	12.11	2.2	18.5
Av.	5.3	44.2	3.3	27.7	3.4	28.1	3.3	27.5
				Group III				
7-6	3.2	26.7	2.3	19.6	6.4	53.7	3.4	28.7
7-13	4.4	37.0	1.9	15.6	5.7	47.4	3.3	27.6
7-20	3.9	32.4	4.2	34.9	3.9	32.9	3.8	31.5
7-27	5.4	45.3	4.9	41.2	1.6	13.6	3.8	31.5
8-3	6.2	50.1	3.1	26.3	2.8	23.6	3.3	26.4
8-10	5.3	44.1	4.2	34.9	2.5	21.0	3.8	31.6
8-18	6.8	57.0	2.9	23.7	2.3	19.4	2.8	23.4
8-31	7.9	65.9	3.2	26.7	0.8	6.5	2.6	21.6
9-7	8.2	68.4	2.7	22.6	1.1	9.1	1.9	15.9
Av.	5.7	47.8	3.3	27.2	3.0	25.0	3.4	27.6
Overall average	5.6	46.4	3.3	28.1	3.1	25.5	3.2	26.8

Table 10. Utilization of time by dairy cattle on bluestem pasture for 24 hour periods, 6:00 a.m. to 6:00 a.m.

Date		Grazing Hr.	Grazing %	Lying Hr.	Lying %	Standing Hr.	Standing %	Ruminating* Hr.	Ruminating* %	Mean Temp.
7-24	Day	4.2	34.9	2.5	20.7	5.3	44.4	3.8	31.8	86.5
	Night	3.1	26.1	6.4	53.2	2.6	21.3			79.0
	Total	7.3	30.5	8.9	36.9	7.9	32.9			
7-25	Day	4.3	35.6	4.5	37.8	3.2	26.6	4.6	37.2	88.8
	Night	3.5	29.4	6.0	50.0	2.5	20.8			81.4
	Total	7.8	32.5	10.5	43.8	5.7	23.7			
8-7	Day	6.4	53.5	3.0	25.0	2.6	19.5	4.2	35.4	86.4
	Night	3.2	27.0	6.7	56.1	2.0	16.9			76.7
	Total	9.6	40.3	9.7	40.4	4.6	19.2			
8-23	Day	6.5	54.4	3.1	26.1	2.3	19.2	3.3	27.5	80.4
	Night	4.0	33.3	6.5	54.0	1.5	12.7			67.5
	Total	10.5	43.8	9.6	40.0	3.8	16.1			
8-24	Day	6.9	57.5	3.6	30.3	1.5	12.5	3.1	26.0	81.1
	Night	4.6	38.5	6.5	53.7	0.9	7.8			69.3
	Total	11.5	48.0	10.1	42.0	2.4	10.0			
9-6	Day	6.8	56.5	3.8	31.4	1.4	12.1	2.2	18.5	69.1
	Night	3.5	29.0	6.9	58.0	1.6	13.1			66.9
	Total	10.3	42.7	10.7	44.6	3.0	12.6			
9-7	Day	8.2	68.2	2.7	22.2	1.2	9.6	1.8	15.3	63.4
	Night	3.2	26.5	7.7	64.3	1.1	9.2			57.5
	Total	11.4	47.3	10.4	43.3	2.3	9.4			
Av.	Day	6.2	51.6	3.3	27.6	2.6	21.8	3.3	27.6	
	Night	3.3	27.0	6.7	55.6	2.0	16.7			
	Total	9.5	39.8	10.0	41.6	4.6	19.6			

*Time spent ruminating was not recorded at night because of the inability to see when cows started or stopped rumination

Table 11. The effect of heredity on the grazing habits of dairy cattle.

Cow No.	Grazing	Lying	Standing	Rumination	Rate of grazing bites per min.	Av. chews per cud	Av. sec. per cud	Av.int. between cud sec.
	Percent							
273A	42.41	29.46	28.03	29.44	32.30	50.70*	47.00	4.40*
274A	38.31	22.83	39.13	28.96	30.20	51.10*	49.20	4.00*
244A	40.50	33.65	27.05	28.25	29.66	55.70*	54.21	4.20*
256A	40.02	22.28	37.70	25.42	26.34	43.50**	46.50	4.30**
	Above data included period from 7-6-49 to 8-19-49.							
316B	46.72	32.22	21.04	26.49	32.57	48.80	51.39	3.96
318B	50.14	28.24	21.62	25.87	28.97	54.00	54.40	3.33
319B	50.40	23.40	26.20	29.35	28.70	40.60	43.17	4.31
320B	49.41	29.54	21.05	26.09	34.16	52.37	50.34	3.69
	Above data includes period from 6-27-49 to 9-7-49.							

*Data from three days observations.

**Data from four days observations.

Table 12. Rate of grazing and rumination daily on bluestem pasture.

Date	Group I: Av. no. bites per min.	Av. no. chews per cud	Av. no. sec. to chew cud	Av. int. bet. cuds sec.	Date	Group II: Av. no. bites per min.	Av. no. chews per cud	Av. no. sec. to chew cud	Av. int. bet. cuds sec.	Date	Group III: Av. no. bites per min.	Av. no. chews per cud	Av. no. sec. to chew cud	Av. int. bet. cuds sec.
6-27	30.3		49.4											
7-8	32.1		50.5		7-1	34.6		52.8						
7-15	20.9		51.6		7-11	32.9		50.3		7-6	33.3		48.7	
7-22	28.1		48.0		7-18	34.2		48.5		7-13	26.9		50.2	
7-29	34.1	48.0	45.3	3.47	7-25	23.5		52.0		7-20	32.0		52.1	
8-5	33.1	49.3	47.0	4.10	8-1	32.3	46.2	47.8	3.93	7-27	30.6		51.1	
8-12	29.8	54.1	55.2	4.18	8-7	26.8	47.9	48.3	3.44	8-3	34.0	54.3	53.1	4.16
8-19	35.9	49.6	48.4	4.01	8-15	28.8	48.4	46.5	3.94	8-10	33.6	52.3	49.1	3.74
8-26	26.4	48.3	45.2	3.90	8-23	31.6	46.9	43.3	4.05	8-18	35.1	52.1	49.0	3.90
9-2	38.2	46.5	46.3	4.04	8-29	34.5	46.8	44.4	4.26	8-31	32.3	51.8	46.1	3.82
9-9	40.9	50.0	45.6	4.00	9-6	34.3	53.0	47.1	4.50	9-7	31.9	47.4	46.0	4.42
Av.	31.9	49.4	48.4	3.96		31.4	48.2	48.1	4.02		32.1	51.6	49.4	4.00

Overall average

Av. bites per min.	31.9
Interval	3.99
Chews/cud	49.7
Sec. to chew cud	48.7

Table 13. Rate of grazing and rumination for 24 hour period.

Date	Av. no bites per min		Av. no chews per cud		Av. no. sec. to chew cud		Av. int. between cuds seconds	
	Day	Night	Day	Night	Day	Night	Day	Night
7-24	24.5	24.6			45.9	52.4		
7-25	23.5	27.6			52.0	54.7		
8-7	26.8	35.8	47.9	51.3	48.3	47.7	3.44	3.85
8-23	31.6	36.1	46.9	50.7	44.1	47.1	3.90	4.61
8-24	31.8	37.4	49.3	50.8	45.9	45.7	3.80	4.16
9-6	34.3	37.5	46.0	53.0	44.2	47.1	4.50	4.60
9-7	31.6	38.5	47.4	48.3	46.0	45.0	4.42	4.10
Av.	29.1	34.1	47.5	50.6	46.6	48.5	4.01	4.22